



'I digitize so I exist'. Searching for critical capabilities affecting firms' digital innovation

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ABSTRACT

Taking into account the increasing importance of digitalization to characterize companies' competitive advantages, and the contextual growing research interest in digital transformation, this paper focuses on dynamic capabilities affecting firms' digital innovation in terms of creation of new offerings, processes or solutions by using a wide range of digital technologies. By means of quantitative research on a sample of managers of 210 firms in Italy, the study performs an ordinary least squares regression to investigate whether and how different knowledge-based capabilities support the process to develop digital innovation, taking into consideration the moderating effect of social media. Despite some limitations, essentially due to the geographical focus of the analysis, the paper contributes to better understand the effect of digitalization in the distinguishing context of the Italian companies, providing useful insights to rethink firms' innovation models.

1. Introduction

In the recent context, stressed by the existential global health crisis provoked by a new coronavirus outbreak (COVID-19), it is an axiomatic fact for most organizations that being present in the market is more and more synonymous with being digital. A number of studies have evidenced the increasing role of video conferencing, special deliveries, telemedicine, e-learning, electronic trading, online marketing, video streaming, and many other modern information technology tools for working and communicating during the mandatory quarantine, while being digital has not only become mandatory but has multiplied opportunities (Savić, 2020; Schilirò, 2020). Also, business resilience has been supported by digital transformation (Fitriasari, 2020).

Despite the aforementioned dystopian scenario, it is evident that digitalization nowadays represents a challenging phenomenon that has radically transformed the way firms do business, as well as how they develop and manufacture their products (Frank, Mendes, Ayala, & Ghezzi, 2019) and manage their relations with stakeholders. A clear example of this evolution is the so-called Fourth Industrial Revolution, a recent trend transforming industrial companies' thinking and operations. The Industry 4.0 paradigm is characterized by the advanced digitalization and integration of industrial manufacturing and logistics

processes, fostering new business models that impact on the firm's overall value chain, the society and the environment (Fonseca, 2018; Frank et al., 2019; Salkin, Oner, Ustundag, & Cevikcan, 2018). Accordingly, in the transition towards smart, manufacturing companies need to improve their capabilities in a standardized, objective and repeatable way (Gökalp, Şener, & Eren, 2017). Hence, in the post-pandemic era, the challenge of digital transformation refers to an evolving process that, in order to be fully exploited, requires firms not only to rethink their entrepreneurial activities (Kuester, Konya-Baumbach, & Schuhmacher, 2018) but, above all, to take actions to redefine their capabilities. In fact, new digital technologies, on the foundations of the digital transformation, are changing the competitive scenario, since they represent a factor affecting firms' dynamic capabilities, considered as the organization's ability to search, explore, acquire, assimilate and apply knowledge about resources and opportunities (Teece, Pisano, & Shuen, 1997). In other words, these are the capabilities that enable business enterprises to create, deploy and protect the intangible assets, such as knowledge, that support superior and enduring business performance (Teece, 2007, 2009). So those capabilities' perception and role are transformed. As proof of this, by implementing modern technologies, there is the opportunity today to reconfigure firms' operations in faster and easier ways that are not

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possible without exploiting the potentialities of digital transformation (Matt, Hess, & Benlian, 2015; Warner & Wäger, 2019). This renewed agility is conceived as “the capacity of an organization to efficiently and effectively redeploy/redirect its resources to value creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant” (Teece, Peteraf, & Leih, 2016, p. 17).

From a strategic viewpoint, agility refers to firms' flexibility and quick adaptation to new ideas and new technologies, among others (Shams, Vrontis, Belyaeva, Ferraris, & Czinkota, 2020), more effectively redeploying and reconfiguring their resources and operations and allowing partners to share knowledge more easily (Debellis, De Massis, Petruzzelli, Frattini, & Del Giudice, 2020). For instance, new digital tools' agility, such as social media, currently represent a key business imperative to communicate with stakeholders, to collaborate with customers or develop new products, by generating and sharing social information associated with the capabilities of information processing (Chuang, 2020), as the present study tries to highlight. In addition, this change is not routine: it requires a high number of continuous and systematic variations in the business processes, together with changes in products, services and structures (Weber & Tarba, 2014). Therefore, strategic agility concerns the systematic deployment of dynamic capabilities to achieve continuous variations within products, processes and so on (Clauss, Abebe, Tangpong, & Hock, 2019), but also to make firms able to face with agility shifts in the external environment (Shams et al., 2020).

However, to create and develop new dynamic capabilities, firms have to deal with the challenging rearrangement of their processes (Eisenhardt & Martin, 2000), integrating and reconfiguring their resources and competences, both internal and external (Teece et al., 1997). From this viewpoint, the relevance of fostering dynamic capabilities in organizations to embrace digitalization is strictly connected to the generation of innovations and creative outcomes, also capturing and exploiting new, unforeseen opportunities, reconsidering their digitization targets, and redefining their operating models and capability-building practices (Daub & Wiesinger, 2015) to respond to changing market circumstances. Some authors define these as digital capabilities (Khin & Ho, 2019). For instance, Westerman, Bonnet, and McAfee (2012) depict digital capabilities as the fundamental digital skills, the ‘building blocks’ to transform the customer experience, operational processes and business models, and, at the same time, the main hindrance to digital transformation when lacking. According to Li, Zhou, and Cheng (2019), the data resources are the main driving force for an enterprise's innovation and building capabilities in the digital age. Sousa-Zomer, Neely, and Martinez (2020) spoke about digital transforming capability as the combination of digital-savvy skills, digital intensity and context for action and interaction, contributing to extend understanding of the microfoundations of dynamic capabilities.

Since dynamic capabilities allow firms both to create new combinations of assets and to renew operational capabilities (Helfat & Winter, 2011), preparedness for such capabilities takes on increasing relevance. For this reason, taking into particular account the knowledge-based view, the dynamic capabilities framework appears to be a powerful lens through which to investigate how digitalization represents a strategic change for organizations and, consequently, constitutes an important source of innovation.

In sum, as is evident in the literature, firms with stronger dynamic capabilities are able better to sustain innovation processes (Bocken & Geradts, 2020; Breznik & Hisrich, 2014; Breznik & Lahovnik, 2014; Ellonen, Wikström, & Jantunen, 2009; Inigo & Albareda, 2019; Inigo, Albareda, & Ritala, 2017; Jantunen, Ellonen, & Johansson, 2012; Michailova & Zhan, 2015; Sheng, 2017; Watson, Wilson, Smart, & Macdonald, 2018; Zhou, Zhou, Feng, & Jiang, 2019). Despite this, and not predictably, to the best of our knowledge the process of generating the capabilities useful to manage digital transformation has received limited attention from academics (Li et al., 2019; Matarazzo, Penco, Profumo, & Quaglia, 2021; Warner & Wäger, 2019). To tackle this gap,

this paper focuses on critical and dynamic capabilities affecting firms' digital transformation (a) reconfiguring the firm and customer value chains, and (b) fostering digital innovation in terms of creation of new offerings, processes or solutions using a wide range of digital technologies (Khim & Ho, 2019; Nambisan, Lyytinen, Majchrzak, & Song, 2017), such as artificial intelligence and machine learning, manufacturing enterprise systems, big data, the Internet of Things (IoT), cloud computing, augmented and virtual reality (Urbinali, Chiaroni, Chiesa, & Frattini, 2018), social media, mobile apps, analytics, embedded devices and so on (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014).

Above all, despite the increasing importance of digitalization to characterize firms' competitive advantages, and the current growing research interest in digital innovation, especially from a technical, architectural or information system viewpoint (Wroblewski, 2018), studies on the managerial perspective need to be better developed. Even though technological skills and competences are important resources required for innovation (Freel, 2005), the emphasis in the management literature on the importance of technology in responding to changing technological conditions diverted attention from the underlying capabilities needed to capture value from technology in order to promote innovative products or processes. Teece (2017) devotes attention to the renewal of digital platform-based ecosystems that are too often neglected, and their dependence on the high-level dynamic capability categories of sensing, seizing and transforming. Warner and Wäger (2019) propose a qualitative study to explore how incumbent firms in traditional industries build dynamic capabilities for digital transformation. Nevertheless, studies examining how organizations build dynamic capabilities for digital transformation are scant, especially in the context of small and medium enterprises - SMEs (Matarazzo et al., 2021).

This study addresses this gap in knowledge by asking the following research question: What are the main critical capabilities concerning firms' digital transformation that support (digital) innovation from a managerial perspective? Firstly, the analysis extends the discussion on digital transformation by contributing to build a scientific knowledge base on this relevant and quite recent topic, which is of interest for both scholars and practitioners (Kumar, Ramachandran, & Kumar, 2020). Secondly, the paper focuses on managing dynamic capabilities in a digital environment, which represents a disruptive change and blurs traditional boundaries among stakeholders (i.e. competitors, suppliers, customers) and markets. Accordingly, and to a greater extent in both managerial studies and enterprises' operations, the capacity for innovation does not exclusively lie within corporate contexts using firms' own resources and capabilities, but is nourished by external relationships, with an emphasis on cooperation (Katz, Turgut, Holzmann, & Sailer, 2013) in the innovative process (Rubera, Chandrasekaran, & Ordanini, 2015; Salter, Criscuolo, & Ter Wal, 2014; Sisodiya, Johnson, & Gregoire, 2013). The relational behaviour of the players involved is interlinked with knowledge resources (Hayter, 2013), from mere access to partners' knowledge platform to the transfer of information and knowhow to the co-production of new knowledge, and it requires organizations that are ever more complex (Klerkx & Aarts, 2013). Therefore, drawing on the dynamic capabilities theory and the disruptive impact of digital technologies, the paper tries to understand what kind of critical capabilities are able to support organizations in scanning the internal and external environment to find new opportunities, capturing value from them, and managing new valuable combinations, to redefine firms' digital innovation and enhance their competitiveness. As discussed, the study focuses on preparedness for knowledge-based dynamic capabilities in relation to the combined exploitation-exploration capability (i.e. ambidexterity) (Dezi, Ferraris, Papa, & Vrontis, 2019) for innovation in a digital environment. In this vein, the third contribution of the paper consists in better understanding the effect of digitalization in the context of Italian firms, by means of a quantitative research offering several insights into how knowledge-based dynamic capabilities could affect digital innovation, whether a narrow or wide-ranging

approach to social media may favour this process, and addressing the allocation of resources for the purpose. Fourthly, the paper enriches the literature on digital innovation management by investigating how established firms could rethink their innovation models, adopting digital solutions that not only allow the creation of new products and services for customers but also contribute to generate those relational changes with a strategic impact needed to improve competitiveness.

In order better to enhance these considerations, the paper is structured as follows. After the introduction, the second section reflects on the topic of digital innovation, examining the main capabilities—knowledge generation capabilities, knowledge acquisition capabilities, and market-sensing capabilities—affecting firms' digital innovation processes. The principal constructs underlying the research objectives are highlighted, taking into consideration the moderating effect of social media on relationships. Via the literature review, the research hypotheses are defined. The third section describes the research design used for the empirical analysis, the conceptual model, and the data collection from a sample of 210 firms in Italy. Subsequently, the results of the web-based survey are presented and discussed, highlighting the role of knowledge acquisition capabilities in digital innovation and the moderating effect of social media. In the paper's conclusion, theoretical and managerial implications are discussed, together with some limitations. In sum, the paper offers a readable perspective regarding the role of dynamic capabilities in effectively supporting digital innovation in Italian organizations.

2. Literature review and research hypotheses

The theoretical framework of this study refers first of all to the theory on digital innovation, which has been explained in the literature by means of several conceptualizations (Sahut, Dana, & Laroche, 2020). While some studies have underlined the responsibility of digital technology in the innovation process and the contribution of innovation to results (Nambisan, Wright, & Feldman, 2019), others have focused on the human capacity to acquire, produce, disseminate and consume information by means of digital tools (Pournaras & Lazakidou, 2008). Some scholars, instead, have concentrated on the recombination in the design and use of a set of digital resources through connections between valuable spaces, with increased interest in the production of digital information to create and capture value in digital innovation (Henfridsson, Nandhakumar, Scarbrough, & Panourgias, 2018).

Indeed, according to a product-centric perspective, digital innovation refers to the involvement of new combinations of physical and digital products to realize new offerings (Lee & Berente, 2012), mainly looking at the role of the underlying infrastructures of information technology (IT) artefacts and of design (Kohli & Melville, 2019). Conversely, focusing on the information technology outlook to a greater extent, digital innovation is related to the adoption of already-existing IT artefacts that are new to the organization. A systemic viewpoint, instead, emphasizes the requirement for significant change within organizations following the application of IT artefacts, enabling the development of new products, services or processes (Kohli & Melville, 2019). These perspectives together define an interesting theoretical framework of digital innovation that highlights activities, outcomes and reflection on the environment, both internal and external, in the digital innovation process (Table 1).

With reference to the aforementioned theoretical framework, it is useful to remember that not all the activities need to be developed in the digital innovation processes or in the listed sequence; in addition, the existing organization of the firm and the environment can have a significant impact on digital innovation.

In any case, what appears to be really critical to digital innovation is the management of knowledge in terms of: (1) the application of existing knowledge; (2) the acquisition of knowledge from sources in the competitive environment; (3) opportunity-sensing by knowledge; and (4) knowledge sharing in communities.

Table 1

Theoretical framework of digital innovation.

Construct	Description
Initiate	Identify, assimilate and apply valuable knowledge from inside and outside firm pertaining to problems and opportunities amenable to digital innovation
Develop	Design and develop a new information system, customize an existing solution, adopt a pre-existing solution
Implement	Install and maintain IS from both a technical and an organizational perspective, including new governance systems, training and processes
Exploit	Leverage existing IS for maximum value. Reuse existing systems, data, etc. for new purposes
Internal organizational environment	The organizational backdrop, including business strategies, cultures, knowledge management and ways of doing
External competitive environment	The competitive marketplace within which the firm is embedded, including fads, fashions and consumer segments
Outcomes	Either projected or actual new business processes, products and services because of digital innovation

Source: Kohli and Melville (2019, p. 203).

This perspective arouses the interest of the present study, exploiting the lens of dynamic capabilities theory through which to analyse digital innovation (Kumar et al., 2020; Teece, 2017; Warner & Wäger, 2019).

Dynamic capabilities include knowledge creation processes, especially in high-velocity environments such as those driven by digital transformation. Dynamic capabilities enable companies to change how they currently make their living or involve the creation of new, situation-specific knowledge that constitutes the basis of new sources of competitive advantage (Bueno, Rodríguez Antón, & Salmador, 2008). Therefore, knowledge creation processes represent a crucial dynamic capability (Nonaka & Toyama, 2015; Smith, Collins, & Clark, 2005). Indeed, according to the dynamic capabilities perspective, the most important capabilities in innovation are exploitation, pointing to the refining of existing knowledge, skills, processes and structures for innovation in the current offering; and exploration, referring to the acquisition of knowledge, skills, and processes completely new to the firm, adding variety, flexibility and novelty to the product innovation (Ferreira, Coelho, & Moutinho, 2020). Therefore it is necessary to analyse the knowledge search both within and across different domains (Gao, Hakanen, & Rajala, 2020).

Thus, the present study tries to understand whether firms' knowledge search for digital innovation depends on internal or external, collaborative, capabilities, and whether their learning is mainly focused on explorative or exploitative paths.

In general terms, 'capabilities' refer to the firm's capacity to deploy resources using organizational processes and routines which develop over time through complex interactions with resources (Grant, 1996; Helfat & Peteraf, 2003); there is therefore a requirement for dynamic capabilities from a knowledge-based perspective, able to modify operational capabilities that turn inputs into outputs using predefined routines and supporting the current operations of the organization, to ensure competitiveness in fast-moving environments through digital innovation (Denford, 2013). Taking into account the most widespread frameworks trying to define these capacities (Denford, 2013), knowledge-based dynamic capabilities are the expression of firms' ability to acquire, generate and combine knowledge resources to manage the environment dynamics. According to this perspective, three sub-capabilities—knowledge acquisition capabilities (KAC), knowledge generation capabilities (KGC), and knowledge combination capabilities (KCC)—represent relevant dimensions of knowledge-based dynamic capabilities (Zheng, Zhang, & Du, 2011). To examine firms' preparedness to foster innovation in a digital environment, the present study focuses on the impact of knowledge acquisition capabilities and knowledge generation capabilities on digital innovation, such as new

forms of knowledge; because of their focus on the integration and application of internal and external knowledge, knowledge combination capabilities are not taken into consideration. Instead, the ability to sense and react to changes in consumer needs and desires, also using technological advances, in order to increase the value offering is a market-sensing capability (Likoum, Shamout, Harazneh, & Abubakar, 2018) that is very interesting for digital innovation.

As a result, the knowledge-based dynamic capabilities taken into consideration for the present study are defined in Fig. 1.

2.1. Knowledge generation capabilities

The generation of new knowledge constitutes a central activity for any organization and it has a great impact on competitive advantage (Salmador & Florin, 2013). Knowledge generation capabilities refer to firms' ability to develop new learning, in the sense of strengthening and refining the activities and processes that facilitate this learning (Zheng et al., 2011). The exploration of new knowledge within the firm occurs by recombination—for instance, through experimentation and internal research and development activities. Also, interactions between explicit knowledge and tacit knowledge through the conversion process extend both the quality and quantity of knowledge, such as workers' practices, collaboration among working teams, interaction and learning—the socialization, externalization, combination and internalization (SECI) process (Karim, Razi, & Mohamed, 2012; Kaur, 2015; Mehralian, Nazari, & Ghasemzadeh, 2018; Nonaka, Toyama, & Konno, 2000). According to internal exploitation, the recombination of previously existing components offers a source of novelty, innovation and new knowledge thanks to the opportunities for mutual learning between organizational groups, which stimulates the creation of new knowledge and the firm's ability to innovate (Denford, 2013). In this vein, knowledge embedded in human, structural and relational capital, as a key differentiating factor in business (Del Giudice & Maggioni, 2014), is strongly connected with innovation (McDowell, Peake, Coder, & Harris, 2018; Subramaniam & Youndt, 2005). Certainly, a particular combination of stocks of knowledge can be exploited by the ability to use these stocks to drive innovation performance (Cabrillo & Dahms, 2018). In the meantime, innovation in IT processes entails the implementation of new information systems and IT solutions to manage knowledge. Hence, the use of disruptive digital technologies impacts the way knowledge is generated within organizations, acting as a facilitator (Santoro, Vrontis, Thrassou, & Dezi, 2018).

Therefore, considering that digital innovation involves new combinations of digital and physical components and knowledge to produce new products (Yoo, Henfridsson, & Lyytinen, 2010), this study hypothesizes the following:

H1. Firms' knowledge generation capabilities directly and positively affect digital innovation.

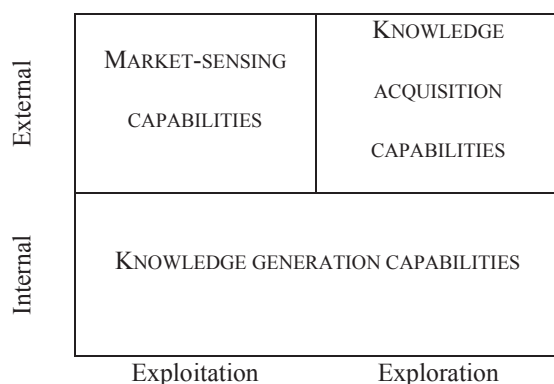


Fig. 1. Knowledge-based dynamic capabilities.

2.2. Knowledge acquisition capabilities

Together with the generation of new knowledge, firms can increase their learning by acquiring knowledge resources from the environment, suppliers, customers and other external stakeholders/sources (Bouncken, Kraus, & Roig-Tierno, 2019; Ferraris, Santoro, & Dezi, 2017; Gölgeci, Ferraris, Arslan, & Tarba, 2019). Knowledge acquisition refers to the firm's ability to identify and acquire useful external new knowledge through the recombination of firm and partner knowledge (Kotabe, Jiang, & Murray, 2011; Papa, Dezi, Gregori, Mueller, & Miglietta, 2018; Zheng et al., 2011). Alliances, equity joint ventures, and joint research and distribution agreements may represent strategic mechanisms to reach this goal. Next to the collaborative creation of knowledge, the search for information outside the firm to absorb into the organization and apply for commercial goals also embodies a knowledge acquisition capability (Lichtenthaler & Lichtenthaler, 2009). Absorptive capacity in terms of firms' ability to explore external knowledge (Lane, Koka, & Pathak, 2006; Zahra & George, 2002), can be realized through partnerships, acquisitions, networks of collaboration and so on. Organizations that are able to select, attract and engage external stakeholders, like customers, users, suppliers and so on, strongly stimulate value creation, which is important to realize digitalization and digital transformation. For instance, the role of customers' and users' knowledge in the digital innovation process has been widely recognized in both business-to-business (B2B) and business-to-consumer (B2C) markets (Abrell, Pihlajamaa, Kanto, Vom Brocke, & Uebernickel, 2016; Benson, 2019).

Since knowledge acquisition capabilities help enterprises to profitably build and renew resources and relations with partners, reconfiguring them as needed to innovate and respond to new needs in the market, this study hypothesizes that:

H2. Firms' knowledge acquisition capabilities directly and positively affect digital innovation.

2.3. Market-sensing capabilities

Knowledge constitutes a fundamental capability for firms searching for new opportunities in the market. Deep analysis of market development in order to intercept future customers' requirements cannot be disregarded. Conversely, customer knowledge, derived from the systematic collection, verification and analysis of data accumulated in transactions with customers, represents a key asset in the process of innovation (Falasca, Zhang, Conchar, & Li, 2017). Business analytics enable firms to use data to identify opportunities and threats, and to select and reconfigure suitable resources (Felsberger, Qaiser, Choudhary, & Reiner, 2020). Other studies (Singh & Del Giudice, 2019) have analysed the impact of big data initiatives as a mediator for dynamic capabilities, enhancing competitive firms' advantage. In that sense, some scholars speak of big data analytics capability (Wamba et al., 2017), defining it as the competence to provide business insights using data management, and of infrastructure (technology) and talent (personnel) capabilities, able to affect firm performance, enabling managers to make decisions based on evidence rather than intuition. Others (Ferraris, Mazzoleni, Devalle, & Couturier, 2019; Rialti, Zollo, Ferraris, & Alon, 2019) define big data analytics capability as an important organizational capability—the skills and routines transforming knowledge inputs into greater value outputs (Ferraris, Santoro, & Bresciani, 2017)—leading to sustainable competitive advantages.

Nowadays, the digital flywheel strategy for market dynamics has acquired relevance thanks to artificial intelligence and other disruptive technologies (Buhalis et al., 2019) that allow the handling of data on consumers' behaviour—and that of other stakeholders, too—making it possible to better steer infrastructures and services to enrich the customer experience, to support the co-creation activities of stakeholders for product innovation, and to enrich, share and measure the economic values deriving from these activities (Lim, Baba, & Iijima,

2018). In a nutshell, to face the broad challenges and possibilities provided by digital transformation, which require careful consideration, technological solutions are able to support evidence-based decision-making (Chierici, Tortora, Del Giudice, & Quacquarelli, 2020), built on the measure and anticipation of future scenarios essential for market development, with positive effects on consumers themselves and society at large (Demir, 2019). In other words, digital tools may amplify organizations' market-sensing ability, enabling the organization to become skilful at learning, perceiving and responding to market dynamics (Alshanty & Emeagwali, 2019), or anticipating business environment changes (Fang, Chang, Ou, & Chou, 2014). Therefore, sensing market capabilities defines the firm's ability to collect and act on information about customer needs, the focal group of stakeholders, and the influence of technology, competition and other environmental forces (Kazadi, Lievens, & Mahr, 2016).

This kind of information regarding firms' customers, along with competitors, suppliers, distribution channels or other market elements, constitutes a relevant portion of the firm's knowledge and influences enterprise's reactions to the market (Alshanty, Emeagwali, Ibrahim, & Alrwashdeh, 2019). Accordingly, firms' market-sensing capabilities have a positive influence on the enterprises' knowledge creation and improve their product innovation processes (Ardyan, 2016) by adopting the latest technology to satisfy market trends. Above all, product innovation requires the exploitation of existing product innovation competences and the simultaneous acquisition of new competences for product innovation, which can be improved through market knowledge.

Therefore, this study hypothesizes that:

H3. Firms' market-sensing capabilities directly and positively affect digital innovation.

2.4. Social media Usage, Firms' capabilities and digital innovation

Finally, the knowledge generated within the firm, or acquired by means of collaboration inside and outside the organizational boundaries, including in response to market changes, needs to be socialized to all the individual and other organizations taking part in the innovation process. Social media, highly interactive platforms such as wikis, weblogs and social networking sites based on Web 2.0 technology, allow individuals and communities to share, discuss and/or modify user-generated content (Piller, Vossen, & Ihl, 2012), creating new ways of interacting (Taiminen & Karjalainen, 2015). This exchange, with a positive impact on the increase of new ideas or the development of new solutions for well-established offerings, also promotes the engagement of consumers and stakeholders with the organization. User-generated content on social media and online communities represent a form of disruptive cooperation that has huge potential benefits for the future growth of society. Among the multiple uses of social media—sales, marketing to derive community insights (Brem & Bilgram, 2015), as a tool for communication or to develop customer relationship management—the application of social media to facilitate information and knowledge sharing in online communities is relevant from the innovation viewpoint, especially related to product information and customer experiences. Above all, this kind of knowledge is useful to inspire new product development and idea generation (de Zubielqui, Fryges, & Jones, 2019). Therefore, social media can be employed effectively in connecting resources, knowledge and capabilities among stakeholders, both customers and other organizations, and can have a critical role in facilitating the interdependencies and knowledge flows that occur in the collaborative innovation processes (Muninger, Hammedi, & Mahr, 2019). Knowledge sharing generates the requisite knowledge to transform ideas into innovation outcomes. Hence, the moderating role of social media need to be analysed.

Therefore, this study hypothesizes the following:

H4a. The greater the usage of social media, the greater the effects of knowledge generation capabilities on digital innovation.

H4b. The greater the usage of social media, the greater the effects of

knowledge acquisition capabilities on digital innovation.

H4c. The greater the usage of social media, the greater the effects of market-sensing capabilities on digital innovation.

3. Methodology

This paper aims to investigate the effects of three different firm capabilities—knowledge generation capabilities, knowledge acquisition capabilities, and market-sensing capabilities—on firms' process of digital innovation and to study the moderating effect of social media relationships. To achieve this result, the paper has adopted a quantitative methodology to analyse data collected from a sample of managers of Italian firms operating in different sectors.

3.1. Sample and data collection

Since the aim of the study is to investigate whether and how different knowledge-based capabilities can support the process of the development of digital innovation, the study investigates a sample of 210 managers operating in Italian firms.

In late 2017, the Italian government launched the second phase of the Italian Industry 4.0 plan. This plan has greatly contributed to Italian firms' understanding of the crucial role digital transformation plays in creating and seizing new business opportunities, increasing their competitiveness and optimizing their efficiency. Furthermore, the Italian incentive plan is one of the most detailed and financially best-endowed in Europe. As a consequence, a year-and-a-half on from its launch, more than 50 per cent of Italian firms had started their path towards digital transformation (Greco, 2018). Recent data suggest that Italian firms are struggling to adopt new technologies, since nine out of ten Italian firms have invested in digital innovation and of the firms which did not do so, 50 per cent are planning to make such investments in the future (Statista, 2019). For these reasons, Italy was chosen as a suitable research setting, and a panel of firms of different sizes and operating in different sectors were randomly selected from the Italian database of LeFac.com, an information portal that has a presence in five different European markets and stores over 230,000 contacts for firms' managers.

Data collection was performed using a web-based survey. Before distributing the structured questionnaire, the survey was pre-tested by three academics and two practitioners who validated the questions in terms of order and comprehension, and provided suggestions and opinions useful to improve platform usability and stability. Between 1 December 2019 and 29 February 2020, the authors emailed 2,850 firms, obtaining 227 completed questionnaires, an 8.0 per cent response rate. Since the paper aims to explore whether and how firms have created and deployed value-added capabilities to define new pathways that, thanks to digital technologies and processes, support firms themselves to develop digital innovation, 17 questionnaires were excluded from the data analysis as respondents had not wholly completed the questionnaire or declared that the firm they work for had not developed any digital transformation. Ultimately, 210 responses were considered, reflecting a percentage (7.3%) that is in line with the response rate usually achieved in an online survey (Cycyota & Harrison, 2006). The questionnaire was developed according to previous literature on dynamic capabilities, knowledge management, social media and digital innovation, and it was structured in two parts with closed questions. The first part investigated firms' specific approaches to internal capabilities, their social media usage, and their approach to and development of digital innovation. The second part was devoted to collecting general information about the firm. Additionally, to reduce the risk of common method bias, respondents did not receive any information about the study purpose during data collection, and questions addressing dependent and independent variables were randomized within the questionnaires (Jahanmir & Lages, 2016).

As shown in Table 2, the managers interviewed mainly operated in

Table 2
Sample characteristics.

	Frequency	Percentage
Firm age		
1–5 years	66	31.5
6–10 years	92	43.8
10 + years	52	24.7
Annual turnover (Firm size)		
Small	96	45.7
Medium	67	31.9
Large	47	22.4
Sector of activity		
Manufacturing	106	50.5
Trade	49	23.3
Services	55	26.2

small and medium firms (45.7% and 31.9%, respectively). The majority of them operated in the manufacturing sector (50.5%), followed by services (26.2%) and trade (23.3%). The sample is mainly composed of firms that have been operating in the market for between six and ten years (43.8%).

3.2. Measures

All items variables used in this study were extrapolated from prior research and adapted to suit the research context. The surveyed managers were asked to self-report their answers on a five-point Likert scale about their firm's knowledge generation capabilities, knowledge acquisition capabilities, market-sensing capabilities and digital innovation. Additionally, respondents were asked to provide information about their firm's social media usage by means of four dummy variables. Finally, respondents were asked about their firm's main characteristics, such as field of activity and annual turnover.

The knowledge generation capabilities and knowledge acquisition capabilities constructs were measured using four scale items each (Zheng et al., 2011). The knowledge generation capabilities construct refers to a firm's ability to internally design and perform managerial, marketing, technological and digital processes useful in the creation of new knowledge. Knowledge acquisition capabilities are about a firm's efforts in scanning the external environment, searching for knowledge that could be transferred to the firm: knowledge acquisition capabilities concern the ability to identify external knowledge that could be useful to improve the firm's competences, to obtain it and to transfer it to the firm.

With regard to market-sensing capabilities, five items were derived from the definition given by Cohen and Levinthal (1990) and Teece (2007), representing the firm's capability to obtain information from several market actors, from customers to partners and competitors, to share it within the firm, and to use it to develop digital innovation. The questionnaire's measurement for firms' social media usage was developed following de Zubielqui et al. (2019), who suggest four dummy variables to investigate whether firms adopt social media for internal exchange of views, opinions and knowledge among colleagues; developing innovative market products; collecting customer opinions and reviews to design innovative products or services that better fit their needs; and involving customers in the development of new digital goods or services. More specifically, in order to measure the moderating variable, respondents were asked to indicate whether their firm adopts social media to perform different tasks. As a result, a score of 0 suggests closed social media usage, whereas a score of 4 denotes a wide-ranging approach to social media.

Finally, digital innovation was measured using six scale items drawn from the study by Khin and Ho (2019). The construct was adopted to capture the quality and features of firms' digital solutions, their innovativeness compared to the firm's previous products and services, platforms adopted, and competitors' solutions already sold on the markets. All items except for dummy variables were measured on a five-

point Likert scale (1 = strongly disagree and 5 = strongly agree).

Additionally, to avoid bias and according to the previously discussed literature, control variables were included. Respondents were asked to provide information about their firm size, indicating the annual turnover, whether small (annual turnover up to EUR 10 million), medium (annual turnover EUR 10–50 million), or large (annual turnover at least EUR 50 million). Moreover, this study takes into account firms' sector of activity as a control variable, since the field of activity seems to affect the probability of implementing digital processes (Ferreira, Fernandes, & Ferreira, 2019).

3.3. Data analysis

To test the hypotheses of the conceptual model presented in Fig. 2, the study uses SPSS 26.0 and performs an ordinary least squares (OLS) regression in which the dependent variable is firms' digital transformation.

Before performing the multiple regression analysis, the authors checked for internal consistency of all variables measured through multi-item scales, obtaining acceptable results as all Cronbach's alphas measured above the suggested threshold of 0.6 (Churchill & Peter, 1984). Furthermore, potential correlations between variables included in the model were evaluated. Table 3 presents the correlation matrix.

Additionally, since all VIF statistics show values not higher than three (Hair, Black, Babin, Anderson, & Tatham, 2010), multicollinearity among variables is not a relevant problem and the model fits the collected data. Moreover, because the analysis is based on self-reported responses, several controls were performed to control for any evidence of common method bias before proceeding with data analysis to examine hypotheses. Firstly, three academics and two practitioners were engaged to pre-test the questionnaire. At the end of the pre-testing phase, their suggestions were used to clarify each item and to reduce its ambiguity. Later, the independent and dependent variables were distributed across different sections. Secondly, any information that could identify the respondents was removed in order to guarantee their anonymity. Thirdly, a *t*-test was used to highlight any difference between early and late respondents (Kanuk & Berenson, 1975), but no statistically significant differences were found. Finally, since common method bias is typically supported when extremely high correlations (≥ 0.90) are detected amongst the study constructs (Bagozzi, Yi, & Phillips, 1991; Lowry & Gaskin, 2014), the correlation matrix was checked. The highest inter-construct correlation in the correlation matrix was 0.648: common method bias was therefore not considered to be a major concern in this study.

4. Results

The main results of the multiple regression analysis are presented in Table 4.

Model 1 shows moderate goodness of fit ($R^2 = 0.306$) and suggests that only knowledge acquisition capabilities are positively and significantly associated with digital innovation, confirming H2. With regard to knowledge generation capabilities and market-sensing capabilities, data do not provide evidence of a relationship between these two variables and digital innovation, rejecting H1 and H3.

Model 2 tests the moderating effect of social media usage on the relationship between knowledge generation capabilities and digital innovation. The model shows acceptable goodness of fit ($R^2 = 0.317$) and suggests that the investigated moderating effect is positive and significant ($B = 0.018$; $T = 1.848$; $p < 0.10$), supporting H4a.

Model 3 presents adequate goodness of fit ($R^2 = 0.321$) and investigates the moderating effect of social media usage on the relationship between knowledge acquisition capabilities and digital innovation. This appears to be positive and significant ($B = 0.023$; $T = 2.140$; $p < 0.05$), confirming H4b.

Finally, the study tests the moderating effect of social media usage on

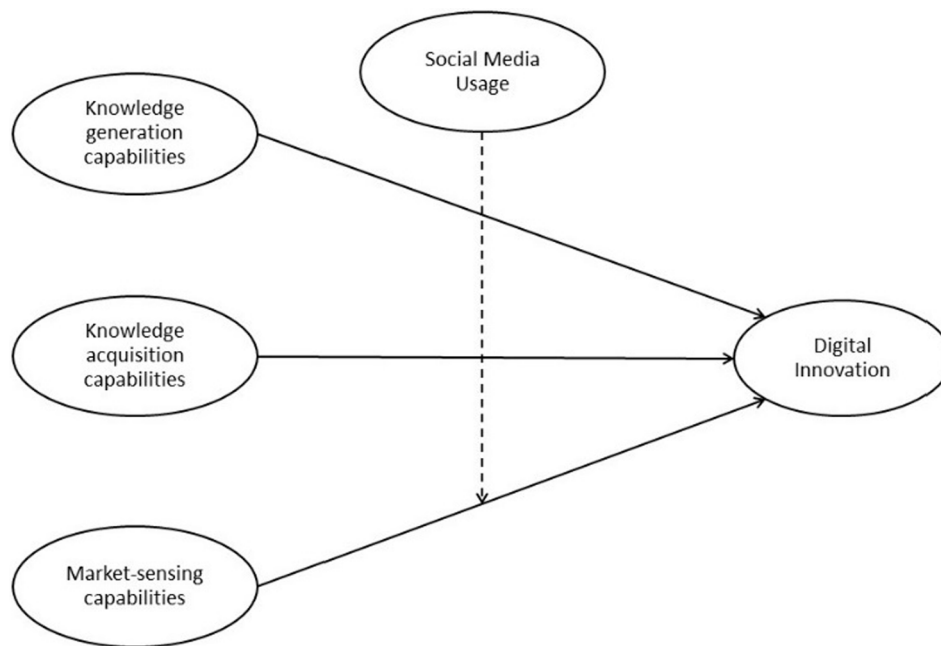


Fig. 2. Conceptual model.

Table 3
Correlation matrix.

	(1)	(2)	(3)	(4)
1. Knowledge generation capabilities	1			
2. Knowledge acquisition capabilities	0.648**	1		
3. Market-sensing capabilities	0.318**	0.148*	1	
4. Digital innovation	0.405**	0.533**	0.116	1

Table 4
Regression results.

	Model 1	Model 2	Model 3	Model 4
Constant	2.679 (9.973)***	2.733 (10.173) ***	2.748 (10.245) ***	2.769 (10.338) ***
Knowledge generation capabilities (KGC)	0.075 (1.087)	0.016 (0.215)	0.056 (0.808)	0.048 (0.692)
Knowledge acquisition capabilities (KAC)	0.357 (6.135)***	0.365 (6.287)***	0.311 (5.050)***	0.367 (6.376)***
Market-sensing capabilities (MSC)	0.020 (0.500)	0.013 (0.324)	0.012 (0.311)	−0.076 (−1.366)
Social media usage (SMU)		0.118 (1.479)	0.160 (2.170)**	0.241 (2.783)**
KGC * SMU		0.018 (1.848)*		
KAC * SMU			0.023 (2.140)**	
MSC * SMU				0.036 (2.465)**
Annual turnover (Size) < 10mln	−0.098 (−0.778)	−0.089 (−0.707)	−0.102 (−0.813)	−0.089 (−0.716)
Annual turnover (Size) > 50mln	0.016 (0.099)	−0.001 (−0.009)	−0.006 (−0.038)	−0.010 (−0.064)
Industry: manufacturing	0.282 (2.047)**	0.273 (1.987)**	0.279 (2.040)**	0.283 (2.076)**
Industry: service	0.128 (0.793)	0.150 (0.933)	0.163 (1.013)	0.164 (1.022)
R ²	0.306	0.317	0.321	0.326

Notes: *p < 0.10; **p < 0.05; ***p < 0.01; T-values in parentheses.

the relationship between market-sensing capabilities and digital innovation. Model 4 shows acceptable goodness of fit ($R^2 = 0.326$), and the moderating effect was positive and significant ($B = 0.036$; $T = 2.465$; $p < 0.05$), confirming H4c.

The models also indicate that the sector of activity has a significant effect as a control variable. Specifically, all the investigated models suggest that the sector of activity positively affects digital innovation, while firms' size does not have a significant effect on digital innovation.

5. Discussion

In today's digital transformation context, where technologies are assuming a basic role for business management and resilience, this study explores firms' dynamic capabilities in terms of the attitude towards searching, exploring, acquiring, assimilating and applying knowledge, resources and opportunities from new technologies (Teece et al., 1997). The analysis focuses on the organization's agility (Teece et al., 2016) in terms of the systematic development of dynamic capabilities (Claus et al., 2019) able to support corporate organizations scanning the internal and external environment to find new opportunities, capturing value from them, and managing new valuable combinations in order to redefine firms' digital innovation boundaries (Dezi et al., 2019).

Within this framework, the study aims to observe, from a knowledge-based managerial perspective, the relationship between digital innovation and firms' competitive advantages, exploring the main critical capabilities concerning digital transformation to support firms' innovation processes. The analysis explores established firms that, due to the market dynamics, can be required to redesign their business models, adopt digital technologies to create new products, and improve customer and stakeholder relations and interactions, requiring more complex organizations involving several operators (Klerkx & Aarts, 2013).

The study contribution is then oriented towards enriching exploration of the relevant, recent topic of digital innovation, contributing to building of its scientific knowledge base, and focusing on managing dynamic capabilities in a digital environment, representing a disruptive change blurring traditional boundaries among stakeholders. The study contribution also improves understanding of the effect of digitalization in the context of Italian firms by means of a quantitative research offering several insights into how knowledge-based dynamic capabilities

can affect digital innovation and how firms can rethink their business models, adopting digital solutions to improve competitiveness.

Therefore, the analysis, based on the substantial significance afforded by the main dimensions of knowledge-based dynamic capabilities explores the relationship of such capabilities with companies' ability to resort to digital innovation (Ferreira et al., 2020) and to predict consumers' behaviour. In addition, the study investigates the role of social media as a moderator that allows the sharing, discussion and/or modification of user-generated content (Piller et al., 2012), creating new ways of interacting (Taiminen & Karjalainen, 2015).

In this sense, the research questions are directly related to the impact of the assumed dynamic capabilities in terms of effects on the digital innovation processes, observing the role of social media as a moderator for knowledge sharing and diffusion.

Within this framework, the empirical analysis performed on a sample of managers of 210 Italian firms shows how knowledge acquisition capabilities are positively related to digital innovation and how the use of social media could moderate the relationship between dynamic capabilities and digital innovation.

Otherwise, the results do not highlight any relationship between knowledge generation, market-sensing capabilities and digital innovation, although this relationship is activated by social media moderation, evidence of the embryonic understanding of the role of the social media in the digital innovation development process.

Comparing the results with prior research on knowledge acquisition capabilities, the evidence confirms how the capabilities of identifying and acquiring useful external new knowledge through the recombination of firm and partner knowledge strongly stimulate the digital transformation process (Kotabe et al., 2011; Papa et al., 2018; Zheng et al., 2011).

In respect of knowledge creation capabilities, the results do not highlight any relationship with digital innovation, unlike prior research that shows how the capabilities developed within the organization are strictly connected with innovation attitude and the use of disruptive digital technologies as a facilitator of organization competitiveness (Del Giudice & Maggioni, 2014; McDowell et al., 2018; Santoro et al., 2018; Subramaniam & Youndt, 2005).

With regard to market-sensing capabilities, the study does not highlight any relationship with digital innovation, with different results from previous research, where the customer knowledge derived from the systematic collection, verification and data analysis of customer transactions represents a key asset in the process of innovation (Falasca et al., 2017) and where business analytics enable firms to identify opportunities and threats (Felsberger et al., 2020), anticipating business environment changes (Fang et al., 2014) using data management and technological infrastructure (Wamba et al., 2017).

In terms of social media usage and its moderating role, the results show coherence with prior research, as social media technologies allow the creation of new ways of interacting (Taiminen & Karjalainen, 2015), with a positive impact on the increase of new product development and idea generation (de Zubielqui et al., 2019), primarily for customer relations management. Therefore, the evidence highlights a positive and significant correlation of social media usage with the three variables observed, confirming prior research on the role of social media in firms' processes of digital innovation.

The theoretical and managerial implications of the study are discussed in the following two subsections.

5.1. Theoretical implications

The theoretical framework for firms' digital transformation is based on some fundamental pillars related to the role of the digital technologies (Nambisan et al., 2019) and digital information (Henfridsson et al., 2018) in digital transformation; to human resources' ability to recognize, acquire and implement new technologies by means of digital tools (Pournaras & Lazakidou, 2008); and to a product-centric perspective

(Lee & Berente, 2012), focusing on new products and services based on digital innovation and information technology (Kohli & Melville, 2019).

Starting from the theoretical background of the management perspective of knowledge in terms of acquisition, application and sharing, the study, using dynamic capabilities theory (Kumar et al., 2020; Teece, 2017; Warner & Wäger, 2019), contributes to better understanding of the effect of digitalization in the context of Italian firms.

The study offers several insights into how dynamic capabilities can affect digital innovation, and enriches the stream of research that concentrates on recombination in the design and use of a set of digital resources through valuable connections, with increased interest in the production of digital information to create and capture value in digital innovation (Henfridsson et al., 2018).

Therefore, this paper is of interest to analyse the dynamic capabilities enabling firms to create new, situation-specific knowledge that constitutes the basis of new sources of competitive advantages (Bueno et al., 2008).

Following this perspective, the study analyses the knowledge search within and across different domains (Gao et al., 2020). It focuses on the relationship with the selected, observed dynamic capabilities, trying to understand whether firms' knowledge search for digital innovation depends on internal or external collaborative capabilities and whether the learning is mainly focused on explorative or exploitative paths (Denford, 2013; Grant, 1996; Helfat & Peteraf, 2003).

5.2. Managerial implications

From a managerial viewpoint, the results clearly suggest that in order to benefit from collaboration, networking agreements and open innovation, and particularly from knowledge inflows externally acquired and shared, innovativeness through digital innovation must be guaranteed in order to allow the exchange and sharing of knowledge and innovation. In sum, the results obtained confirm that the absence of such practices in organizations that do not apply digital innovation could push these companies out of the market over the years due to the underlying lack of acquisition and implementation of adequate dynamic capabilities.

Taking into account the most widespread frameworks addressing the role of dynamic capabilities, the three sub-capabilities—namely, knowledge acquisition capabilities, knowledge generation capabilities, and knowledge combination capabilities—represent relevant dimensions of knowledge-based dynamic capabilities (Zheng et al., 2011) that must be considered by the company management in the face of competitive challenges. Inspired by the analysis results, firms have to focus on the impact of knowledge acquisition and generation capabilities on digital innovation to face today's global market challenges, including the use of technology to increase the value offering (Likoum et al., 2018).

The exploration of new knowledge within the firm occurs by recombination—for instance, through experimentation and internal R&D activities, and through the interactions between explicit and tacit knowledge, in terms of both quality and quantity, including workers' practices, collaboration among working teams, interaction and learning (Kaur, 2015; Nonaka et al., 2000).

The emerging relationship between knowledge acquisition capabilities and digital innovation can be traced back to the opening of organizational boundaries and the logic of collaboration between corporate stakeholders. Over time, market complexity has led to deep specialization in the various phases of the production cycle and to the adoption of co-creation and co-researching strategies that have favoured the spread of the necessary digital technologies for their management and development.

Furthermore, the aforementioned co-creation and co-researching strategies have seen the spread of contractual and business law schemes that stimulate the development of collaboration (network contracts, homogenization of international law, etc.) between business

operators. These new practices of collaboration are strengthened by the moderating function of social media, which facilitates the dissemination and sharing of knowledge and innovation.

Knowledge generation capabilities do not show a first-level relationship with digital innovation in the embryonic adaptation of business processes with respect to the adoption of modern digital technologies. This is due to the investments required for their introduction and the consequent implementation by the business organization, with primary reference to the training of human resources and operating routines, as recent government interventions aimed at promoting the adoption of digital technologies (Industry 4.0) show.

Similarly, the adoption of digital technologies does not highlight a first-level relationship with the ability to perceive and anticipate market trends, showing no relationship between investments in technologies and the capacity to understand and predict the dynamics of market demand.

Both knowledge generation capabilities and the adoption of digital technologies are activated by the social media function, however highlighting for the first the low relevance of the social media, still underused for internal knowledge development.

Market dynamics may be considered suitable for potential investigation within the statistical universe, aiming to understand digital innovation processes.

Conversely, external collaborations and partnerships established with stakeholders which aim to integrate and share innovation paths have been shown to positively influence the innovation direction of business processes by fostering the use of digital innovation systems.

6. Limitations and future research perspectives

Notable evidence emerges from the analyses carried out of the relationship between digital innovation and the dynamic ability to acquire knowledge from the external environment, also thanks to the establishment of collaborative interactions with other groups of consumers or organizations. The amplifying effect generated by social media seems particularly compelling, making previously unknown forms suitable for profitable collaboration and communication activities and favouring companies in the acquisition of innovative skills in a very energetic context.

The empirical analysis was conducted in Italy, which proved to be particularly to allocate Industry 4.0 incentives. The analysis was carried out by observing firms' specific approaches to internal capabilities and social media usage, and the general approach assumed towards digitalization. The evidence collected showed the relationship between digital innovation and the ability to acquire information and knowledge from the outside, confirming the role of synergic collaboration among stakeholders, aimed at creating innovations, wherein information technologies play an essential role. Furthermore, the function of social media, as platforms able to encourage the synergistic share of knowledge and innovations, is strategic in relation to the internal and external innovation capabilities of the organization and the possibility of accentuating strategic perception of market pulses. In this sense, the present study defines the dynamic capacities that can be considered fit, or necessary, to preserve or rise the competitive advantages on a digital economy context highly affected by the presence of social media.

However, while highlighting the relevant results presented above, the study has limitations that may offer useful extensions and targeted analysis aimed at further enriching knowledge on the digitalization of firms, a highly debated but still scarcely explored topic from a managerial viewpoint. The limitations include the territorial parameters of the analysis that, although of significant interest for national incentive policies, represents a peculiar observation cluster. It would be useful to expand the sample and geographically extend it. Involving organizations from other countries could ultimately detect socio-cultural differences, where different uses of digital tools and social media can emerge, differently affecting digital innovation. Furthermore, the sample mainly

includes micro- and small and medium-sized enterprises; additional clusters made up of medium and large enterprises could be involved, focusing the analysis on the effect of firm size on digital technology adoption. Further variables of interest may include the professional profiles and the levels of education of a company's workforce, which are normally salient in the perception of added value and a full understanding of digital technologies' key role.

Future research could also focus on specific sectors which, based on the type of business model and the nature of the products and services offered, may be characterized by particular features connected to the use of digital innovation. In addition, the hypotheses of the study could be extended to international collaboration among companies operating in different countries and that are characterized by different business cultures. In that case, the dissemination of knowledge capabilities would be analysed, with specific reference to the forms of aggregation and cooperation among networks and to other forms of networking among businesses, academies and think tanks. Finally, further proactive research related to the introduction of new technologies (for example, the impact of 5G technology) may be of interest, to raise the entrepreneurial use of digital technologies. Even so, the suggestions presented in this paper are only a few points of interest for further research on the topic, given the pervasive potential of digitalized business models that may impact consolidated operating methods from both an organizational and commercial point of view.

7. Conclusions

Within the frame of the modern industrial revolution in which digital technologies have assumed high strategic importance for corporate competitiveness, dynamic capabilities, firstly with regard to acquiring specific knowledge and skills (Freel, 2005), are facilitated by the spread of digital technologies, representing a critical success factor (Gökalp et al., 2017; Fonseca, 2018; Frank et al., 2019; Kuester et al., 2018; Salkin et al., 2018). The recent COVID-19 pandemic has highlighted, even in an embryonic way, a thoroughly novel and futuristic mode of interaction among economic operators. A stronger focus on digital platforms has emerged in conjunction with a sudden need to digitally adjust the value chain of the firms. In this sense, the essential role of dynamic capabilities reflects the organization's ability to search, explore, acquire, assimilate and apply knowledge about resources and opportunities (Teece et al., 1997) as a competitive factor. Within this context, the role of internal and external relations has clearly emerged, which, by establishing synergistic interactions with the main stakeholders, require the adoption of digital technologies to increase the value of the information and knowledge shared (Katz et al., 2013; Rubera et al., 2015; Salter et al., 2014; Sisodiya et al., 2013). The analysis here leads to the development of numerous insights into the dynamic capabilities that can influence digital innovation by better developing the relationship with the knowledge dimension. Management of the knowledge dimension creates dynamic capabilities, gathering the type of critical knowledge that can potentially support an organization in its acquisition and enhancement of the opportunities offered by digital technologies for competitive purposes. Also relevant is the way established companies approach the adoption of digital technologies, aiming to adjust their business model both to the production of new goods and services and to new forms of knowledge relations with external organizations.

Finally, the possible effects on digital innovation produced by the ability to observe and proactively predict market variables, combined with the moderating function performed by social media in terms of sharing and disseminating knowledge, need to be taken into consideration.

In sum, companies need to be sincerely committed to supporting the distinct skills related to knowledge acquisition capabilities, together with the ability to perceive market dynamics through the use of digital technologies (Likoum et al., 2018). These, in turn, allow organizations to

explore and competitively exploit the knowledge and skills acquired, promoting a virtuous cycle.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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